

# Analysis on the Measures of Collision Avoidance and Legal Liability of Vessels at Anchor in Collision Accidents

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**Abstract:** When the risk of collision exists between a ship underway and an anchored ship, the ship underway should take active measures to avoid the collision as required by the rules, but it doesn't release the anchored ship's obligation to take all possible measures to avoid the collision or reduce the consequences of the collision. It is often misunderstood that the anchored ships do not bear the liabilities for collision losses, or only bear a small proportion of the responsibility due to the limitation of their maneuvering ability. However, in practice of maritime trial, lots of anchored ships were decided by the maritime courts to have faults and bear the liabilities for the collision damages because they failed to maintain a proper lookout, detect the presence of the collision risk in time, and issue a warning of the danger to related ships, or failed to notify the master of the own ship to heave up anchor for emergency manoeuvring. This paper, through statistical analysis of a large number of cases related to ship collision cases, analyzes the requirements of laws and regulations on the duty of anchored ships, the common faults and the difficulties and obstacles in taking action by anchored ships to avoid collision, studies a great number of maritime cases, summarizes the lessons learned from those cases, and put forward the reasonable and lawful suggestions and actions by the anchored ships to avoid collision so as to provide advice for shipping companies, ship managers, ship masters and crew members.

**Keywords:** Ship Collision, Anchored Ships, COLREG1972, Negligence and Faults, Liabilities

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## 1. Introduction

Collision of ships means an accident arising from the touching of ships at sea or in other navigable waters adjacent thereto. The collision of ships is an act of tort and the party at fault shall bear the tort liability. [1] When collision cases occur at sea, judging each party's faults are generally based on the International Regulations for Prevention Collisions at Sea, 1972 (COLREG1972). In the dealing with ship collision cases at sea, it is often misunderstood that the anchored ships do not bear the liabilities for collision losses, or only bear a small proportion of the responsibility due to the limitation of their maneuvering ability. However, in the collision cases between ships at anchor and ships underway, the faults of the anchored ship is not exempted because of the limited maneuverability.

Anchored ships are sometimes attached by the court to bear a large proportion of collision liability, and in some extreme cases may be judged to bear major liability or even full liability. The International Regulation for the preventing Collision at Sea 1972 (COLREG1972) does not provide directly for the obligation of anchored ships to avoid collisions, but from the rules of the COLREG1972, every ship shall use all available means to maintain a proper lookout, determine the risk of collision, use good seamanship, and take active and early action to avoid collisions. In addition, Rule 2-Responsibility, Paragraph (a) prescribes: "Nothing in these Rules shall exonerate any vessel, or the owner, master or crew thereof, from the consequences of any neglect to comply with these Rules or of the neglect of any precaution which may be required by the ordinary practice of seamen, or by the special circumstances of the case." [2] Therefore, neglect in

complying with the regulations may lead an anchored vessel to liabilities in collisions cases. [3] Nevertheless, due to the limitation of maneuverability, the effective measures that can be taken by anchored ships to avoid collision with other ships are quite limited. The court should also take full account of the actual situation of the anchored ships when deciding such collision cases involving anchored ships. This paper analyzes the requirements of laws and regulations on the duty of anchored ships, the common faults and the difficulties and obstacles in taking action by anchored ships to avoid collision, studies a great number of maritime cases, summarizes the lessons learned from those cases, and put forward the reasonable and lawful actions by the anchored ships to avoid collision so as to provide advice for shipping companies, ship managers, ship masters and crew members.

## 2. Maneuvering Characteristics of Anchored Ship

Anchoring refers to a state of ship operation in which the ship is controlled in a certain water area by the anchor and anchor chain. A ship at anchor, whose anchor claw grasps the riverbed or seabed, can only drift or rotate around the anchor position within the limit range. When a ship is at anchor, her maneuverability is seriously restricted by the following reasons.

### 2.1. Normally Finished with Her Engine (F. W. E)

When a ship is ridding anchor in the anchorage, she is usually in the state of F. W. E. At this time, the main engine lub oil pump, fuel pump, cooling pump, sea water pump, etc. are stopped; usually, only one generator running to supply power for the living area and deck lighting, which can not meet the power requirements of steering gear, anchor gear and cargo winch; the main air cylinders only maintain pressurized; the boiler is generally stopped as well; the engine room may not be manned.

When the main engine needs to be started in case of an emergency, the crew in the engine room shall be informed in place to start the lubricating oil pump, fuel pump (directly start with light oil in case of emergency, without heating), engine room fan and auxiliary fan of main engine. At this time, only one generator is running, and the load is usually insufficient, so it is necessary to start another generator to ensure enough power supplied to the windlass and steering gear. For the well-trained engine crew of a ship, if successful, it can be completed in no less than 3-5 minutes. The specific time varies from ship to ship, but three minutes is the limit time for general sea going ships. It should be noted that the emergency start-up procedure omits the time-consuming process of turning and blowing the main engine. The biggest risk is that there are impurities and water in the cylinder that can not be blown out, which may damage the cylinder and crankshaft.

Generally, the main engine of a ship in operation will stop only when it is berthing or anchoring. It is the best time for engineers to maintain and repair the main engine when the

main engine stops running. However, when berthing, the engine room staff are busy in dealing with the matters such as refueling, receiving provisions and spare parts, port state inspection, ship visiting and other work. Therefore, the anchoring period is often the best time for the engine department to arrange the maintenance of the main engine. In case that the main engine is under maintenance, it will take much longer time to make the engine to start, and even sometimes emergency standby operation is not applicable. Maintenance of the main engine during anchoring is an important measure to ensure the safety of the ship, which is a normal and reasonable work arrangement and not prohibited by laws and regulations. In general, when a ship is intended to repair her main engine in the Vessel Traffic Service (VTS) monitoring area, she needs to report to VTS and get permission. VTS usually gives permission to the vessels for the repair work.

### 2.2. It Takes Long Time to Heave up Anchor

When the ship is anchored, the anchor is in the state of grasping the sea bottom. In order to ensure that the anchor has enough holding force, it is necessary to loosen the anchor chain with sufficient length and lay on the sea bottom. [4] Taking the conventional Panamax ship as an example, according to the normal anchor chain heaving up speed, one shackle/3 minutes, to heave up an anchor with 6 shackle in water, it will take 18 minutes, and plus the time required for the crew from living area to the forecandle deck and relative preparation, the normal operation time may take at least 25 minutes.

### 2.3. Complex Navigable Environment

When vessels are ridding anchor in the anchorage, the distance between them is usually less than 1 nautical miles, thus making the space for ships' manoeuvring is quite limited. Lots of ships may enter or leave the anchorage, and therefore many collision situation is formed between the ships entering or leaving the anchorage and the anchored ships. In this traffic environment, on one hand, ships entering and leaving the anchorage area are limited by the area and the surrounding anchored ships, and they have to pass through anchored ships in a short distance. On the other hand, the speed of ships ready to entering or leaving the anchorage are very low, and their courses are significantly affected by wind and current. [5] Taking a ship with speed 6 knots as an example, if the beam current reaches 3 knots, the leeway set will reach to 27° or more, thus making it quite difficult to handle the ship.

Through the analysis above, it can be seen that, under normal circumstances, it is not realistic to use main engine and heaving up anchor to avoid collision by an anchored vessel when she detects the collision situations. What's more, immediate start of ship's main engine in case of emergency may cause sever damage to the main engine. That's why, in normal practice, the crew of an anchored vessel seldom take action to prevent collision with vessels underway by starting main engine or/and heaving up anchor in short time.

### 3. Legal Analysis on Common Faults of Anchored Ships

In this paper, a large number of collision cases related to anchored ships are collected and analyzed. Through induction and comparative analysis, the faults of anchored ships in collision accidents are summarized as follows.

#### 3.1. Improper Selection of Anchor Position

In normal practice, the ship shall anchor in the anchorage as defined on the chart or the area designated by the VTS. If there is no defined or designated area, a ship shall avoid to drop anchor in a position which obstructs the safe passage of other ships. [6] The international regulations for the prevention of collisions at sea 1972 (COLREG1972) requires ships to avoid dropping anchor in narrow channels or at the ends of navigable fairways<sup>1</sup>. Rules On Collision Avoidance In Inland Waters Of The People's Republic Of China (hereinafter referred to as "Collision Prevention Rules in Inland Waters") requires that ships should not anchor beyond the anchorage area, not anchor or take shelter in narrow, curved channels and other navigation obstructing areas, etc.<sup>2</sup> [7] In addition to the Collision Prevention Rules in Inland Waters, the regulations formulated by transport authorities also have requirements on the anchoring positions. For example, Chapter 4 of Ship Routing System of the Yangtze River Shanghai Section stipulates that ships should anchor in the anchorage promulgated by the competent authority, report to the traffic control center before anchoring, not anchor in and keep clear of anchoring prohibited area, select safe waters for emergency anchoring<sup>3</sup>. [8]

There are two main risks for the ships underway in vicinity if the anchored ship does not properly select anchor position.

1) If a vessel doesn't select proper anchorage and drops anchor in or near the fairway, or in the customary route, it is very hard for other vessels sailing in those waters to predict the existence of the anchored ship and may cause misjudgment for the traffic situation. For example, in the collision case of "China Ping An Property Insurance Co., Ltd., Liu'an Branch vs Zhang Xuelin and Zhang Fangyuan", When the officer on watch (OOW) of M. V. "Yuan Sen 9" found an anchor light displayed by M. V. "Anhui Harmony 988", the first reaction of the OOW on "Yuan Sen 9" was that the light was a navigation aid, but not an anchored ship in the fairway.<sup>4</sup>

2) In crowded waters or narrow channels, in case of the existence of anchored ships, the collision avoidance space is greatly limited. In extreme cases, this will make the ship unable to pass safely. In the civil judgement of second instance "Shao Junou vs Zhoushan Dingheng Shipbuilding Co., Ltd., Shanghai Dingheng Ship Management Co., Ltd.", due to

heavy fog, "Dingheng 9" anchored in the east of Yuanshan Island in the north of Fodu waterway. The court found that the anchor position of Dingheng 9 did not meet the requirements of good seamanship and determined "Dingheng 9" to bear secondary responsibility for the collision result.

#### 3.2. Incorrect Display of Lights and Shapes

The correct display of lights and shapes is helpful to identify and judge the type, size, dynamic and working nature of ships at sea, and also provide effective information for the OOW so as to make correct decision on collision avoidance.

According to the Rules of COLREG1972, an anchor ball shall be displayed in the daytime when a power-driven ship is anchored, the anchor lights and deck working lights should be displayed from sunset to sunrise; and the anchor lights and anchor ball should be displayed at the same time in daytime with poor visibility<sup>5</sup>. By observing the lights or shapes of the anchored ship, the actual state of that ship can be clearly determined and collision avoidance action can be taken properly by OOW. If an anchored ship fails to display the proper lights and or shapes according to the requirements of the rules to indicate its anchoring state, it may cause other ships to make a wrong judgment or unable to detect the existence of the ship. Once the collision accident occurs, the anchored ship may be deemed to undertake the main liability for the collision damage. In the "LLANOVER" case, the collision between the sailing ship "LLANOVER" and the anchored ship "Presto" resulted in the sinking of "Presto".<sup>6</sup> In this case, "Presto" was in anchoring state, a lookout was arranged and "Presto" was continuously sounding her fog signals, but the anchor light was not displayed. Because "Presto" failed to display anchor light at night as required, the sailing ship "Llanover" could not observe the specific position of "Presto", and finally collided with "Presto". The judge Mr. Pilcher dismissed all the charges of negligence of the ship "Presto" against the ship "Llanover", and judged that the anchored ship "Presto" should bear all liability for the collision. It should be reminded that this case happened in the 1940s, and modern ships are generally required to install radar equipment. Therefore, the defense on the ground that other ships not displaying anchor lights may not convince the judge in nowadays.

#### 3.3. Neglect of Lookout Leads to No Alert to Collision Risk

COLREG1972 requires that every ship shall keep a proper lookout at any time by visual and hearing as well as all available means suitable for the environment and situation at the present circumstances, so as to make a full appraisal of the situation and collision risk<sup>7</sup>. The requirements for lookout in "Collision Prevention Rules in Inland Waters" are basically the same as those in COLREG1972. "Rules on Watch-keeping for Seafarers of People's Republic of China" (hereinafter referred to as "Watch-keeping Rules") stipulates more specific

1 Article 9 (7) and 10 (7) of the COLREG1972.

2 Article 25 of Collision Prevention Rules in Inland Waters.

3 Article 20, 21 and 22 of Ship Routing System of the Yangtze River Shanghai Section.

4 (2016) Case No.1307 of Hubei Civil 72. In this case, the Nantong Maritime Authority issued an accident liability confirmation letter, that "Anhui Harmony 988" illegally anchored, and should bear the main responsibility, and the court also considered that "Anhui Harmony 988" anchoring in the waterway constitutes a greater fault.

5 Rule 30 of COLREG1972.

6 (1943) 77 Ll. L. Rep. 198.

7 Rule 5 of COLREG1972.

requirements for lookout. Its Article 46 additionally stresses that when an anchored ship finds that another vessel is coming too close or in any doubt, she shall notify and alert the coming vessel.

For understanding the Rule-Lookout, the key point is to adapt to the environment and circumstances at that time. Vision and hearing are the most basic means of lookout. [9] Vision is used to observe the external navigation environment, especially to judge the ship's dynamic state by the lights displayed on the passing ships at night or restricted visibility. [10] However, when the visibility is poor, OOW's sight will be greatly limited, and the availability of visual lookout will be greatly weakened. Through hearing, the OOW can get the whistle signal of other ships and determine the movement, approximate bearing and distance of other ships. However, when there are many ships around, the sound signals are dense or the sound waves are refracted, and the reliability of hearing will be also greatly reduced. [11] In addition, though radar is an effective navigation aid for OOW to maintain a good lookout, radar sometimes is interfered by rain and sea clutters, and false echo interference such as side lobe, multiple reflection and indirect reflection will affect the performances of radar. It is also possible that radar is unable to detect non-steel ships with weak radar wave reflection. As for AIS and VHF, they can only be used as assisting means, and single AIS or VHF information can not be used as the basis for assessing the situation. In view of this, appropriate lookout is a process of systematic and comprehensive observation and assessment on the current situation by all available means, and the information obtained needs to be cross checked to avoid mistakes.

The vast majority of collision cases are caused by the neglect of lookout and lack of alert to the risk of collision. Statistics on investigation reports by experts show that 99 cases out of the 108 collision case in recent years were as a result of negligence of lookout.<sup>8</sup> [12] Although the Lookout clause of COLREG1972 does not distinguish the duty of care to be borne by the vessels underway and the anchored vessels, but requires all ships to keep an effective lookout, so the neglect of lookout by anchored ships often lead to a certain collision liability. In the case of collision between "Ningshenhai Oil 2" and the anchored ship "Jinghua 1020", the anchor lights, anchor balls and deck lights were normally displayed when the "Jinghua 1020" anchored at the anchorage of Yuanyu island. The court of first instance held that "Jinghua 1020" violated Rule 5 of COLREG1972 and neglected to maintain a good lookout. As an anchored ship, "Jinghua 1020" had slightly negligence of proper lookout and should bear 10% of the collision liability<sup>9</sup>. In the case of "Hong Kong Sea Lion Shipping Co., Ltd., China Pacific Property Insurance Co., Ltd. Ningbo Branch vs Tolson Shipping Singapore Co., Ltd.", the radar range of M. V. "BEILUNSEALION" was set at 3 nautical miles during the anchoring period.

"BEILUNSEALION" initially noted the coming ship "THORENERGY" only when they were 1.5 nautical miles away. At a distance of 1 nautical mile, the two ships called each other by VHF 5 minutes before the collision, and "BEILUNSEALION" was judged to bear 10% responsibility for the collision due to her negligence of lookout.<sup>10</sup>

This paper holds the opinion that the judgment of neglecting to lookout as minor negligence is not contradictory to the rules of COLREG1972, and it is in line with the requirements of navigational practice for the distribution of the duty of care between the anchored ships and the ship underway. The collision avoidance measures adopted by anchored ships are different from those ships underway when collision risks are determined. In general, the actions that can be taken by anchored vessels after their obtaining the dangerous information, are relatively passive measures, such as sounding the warning signal, contacting with the vessel concerned with VHF, etc. It is very hard and usually impracticable for an anchored vessel to take collision avoidance action by using her engine and rudder to avoid or other manoeuvring operation at critical moments.

#### **3.4. Failure to Take Reasonable Avoidance Measures**

In view of the diversity of the situation encountered at sea and the difference of ship's handling ability, whether a ship is underway or at anchor, the navigation rules try not to instruct the crew on how to operate and how to prevent collision, but only regulate the time to take measures and the actions to be avoided.

From the perspective of navigational practice, the measures that can be taken by anchored vessels including: 1) sending warning signals to ships affected, particularly to vessels underway; 2) heaving up or lowering anchor chains as appropriate; 3) notifying engine room to heave up anchor to avoid collision; 4) discarding anchor and anchor chain to avoid collision in case of emergency. [13] However, except for the first measure mentioned above, other measures are quite limited, because those measures, as analyzed in section 2 in this paper, take longer time and are not immediate actions. In practice, there are few cases in which the last three avoidance measures can be taken successfully to avoid collision, and few judgments accuse the anchored ships of not taking these measures.

To sum up, the emergency measures that can be taken by anchored vessel to avoid collision with other vessels are relatively limited. The most effective and common way is to determine the risk of collision as soon as possible, contact with the vessel affected, and use sound and light signals and VHF communication to remind them about the situation. Surely, under various collision situations, different actions required. This paper does not intend to encourage the crew to give up any measures of collision avoidance, and the officers on watch should exercise their due diligence as required by the rules and good seamanship.

8 Pang Kaihua, analysis of 108 maritime investigation reports on ship collision accidents, shipping trade Bulletin No. 35.

9 (2016) Case No.2789, Zhejiang Civil72.

10 (2017) Case No.868, Liaoning Civil72.

### 3.5. Time of Taking Actions for Anchored Vessels

Both COLREG1972 and Collision Prevention Rules in Inland Waters divide the obligation of ships to avoid collision into three stages, namely "risk of collision", "close quarter situation" and "immediate danger situation". However, there are no provisions on the time of measures taken by anchored vessels. In the Watch-keeping Rules, the right time to take avoidance actions are given according to different situations. For example, when the anchor position of another ship is too close to own vessel, the own vessel shall give warning of the situation to that vessel; For vessels passing-by or engaged in anchoring operation, when finding the existence of risk of collision, the other party should be warned; When the current is diverted, emergency measures should be taken when necessary to prevent the anchor of own ship or other ships from dragging resulting in a dangerous situation; When the anchor of own ship or other ships are dragging or the vessels passing-by are too close to each other, all effective measures should be taken decisively<sup>11</sup> [14]. Some scholars are of the opinion that the time for the anchored ship to take measures to avoid collision is the time of immediate danger occurring<sup>12</sup> [5], which is also reflected in the trial. This paper holds that the time for an anchored ship to take measures should be as stipulated in Regulations on Watch-keeping for Seafarers, which is more objective and pragmatic, but not limited to the "immediate danger situation" as stipulated in COLREG1972. However, it is a pity that there is no clear definition of "safe distance", "time of risk" and "dangerous situation" in the rules, so it is difficult to interpret them in practice. From the view of good seamanship, it is very difficult for an anchored ship to make a timely response to the immediate danger and urgent situation. It should be judged when the collision risk occurs. Of course, if the collision risk has been formed and the ship takes reasonable measures after communication, there is no need to take further avoidance measures. However, when the other party is unable to be contacted or the other party has not responded to the ship's warnings and suggestions, it is suggested that more active avoidance measures should be taken as soon as possible.

## 4. Conclusion and Suggestions

As mentioned in the beginning of this paper, although the maneuverability of the anchored ship is limited, once a collision accident occurs, the faults of each party and the causal force between the faults and the collision damage will become the main factors to determine the collision liability. Based on this, this paper puts forward the following suggestions for ship owners, ship managers, ship masters and OOW:

1) Drop anchor in the anchorage as shown on the nautical chart, VTS designated waters or other suitable waters not

impeding normal navigation. If in the VTS monitoring area, it is necessary to comply with VTS's recommendations or obtain permission to anchor, which is the preliminary evidence of reasonable selection of anchorage. While at anchor, the anchor lights and shapes must be checked at each shift. If there is no such anchorage, the anchoring vessel shall not impede the normal traffic flow and safe passage of other vessels.

2) Keep regular lookout, detect collision risk as soon as possible, and place the radar at an appropriate range. If only one radar is in use, it is recommended to switch between long and short range regularly. [15] At the same time, although technically feasible, the use of radar Guard Zone and other functions is not encouraged because it may reduce the lookout alertness of OOW.

3) Observe and assess the dangerous ships in vicinity as soon as possible, and establish contact with the suspicious ships as soon as possible to clarify the intention of coming ships. If the incoming ships fails to pass by in the safe distance, give warning to them in time. If contacting by VHF call, the time and content of the call should be recorded.

4) In case that the contact cannot be established, the intention of coming ship cannot be determined, or movement of that ship may cause dangerous situation, the master, engine room and deck department personnel shall be informed immediately for emergency operation.

5) In case of an accident, the evidence shall be taken as soon as possible, including VDR, statements of the crew members, track and actions of vessel concerned, charts in use, log book, etc. If possible, appropriate video recording and other measures should be taken.

## References

- [1] Zhang Hongkai. Research on Tort Liability of Ship Collision [D]. Dalian Maritime University, 2019.
- [2] The International Regulation for the preventing Collision at Sea 1972 (COLREG1972).
- [3] Zheng Yingxi. "The legal effect of Rule 2 (a) of COLREG in Korean Legal System." DONG-A LAW REVIEW [J]. 62 (2014).
- [4] Tianding Han, Wanzheng Ai. Measures for the Safe Operation of Anchoring in a Storm [J]. IOP Conference Series: Materials Science and Engineering, 2018, 301 (1).
- [5] Zhang Pengfei, Zhao Jinsong. Discussion on the Obligation to Avoid Collision of Anchored Ships under COLREG1972 [J]. Marine Technology, 2012 (04): 71-72.
- [6] Shan Dan. Liability of Anchor Ships in Collision Accidents [J]. Navigation, 2020 (04): 16-18 (In Chinese).
- [7] Rules on Collision Avoidance in Inland Waters of The People's Republic of China.
- [8] Ship Routing System of the Yangtze River Shanghai Section.
- [9] Astrid Zekić, et al. "Analysis of the Level of Knowledge And Understanding of Regulations For Preventing Collisions At Sea." Scientific Journal of Maritime Research 29. 2 (2015).

11 Rule 46 of "Regulations on Watch-keeping for Seafarers of People's Republic of China".

12 Zhang Pengfei and Zhao Jinsong, Discussion on the avoidance obligation of anchored ships [J]. China navigation technology, March 1, 2013.

- [10] Chen Hong. Discussion on Ship Safety Countermeasures in Fog Navigation Collision Accident [J]. Tianjin Navigation, 2018 (04): 16-17 (In Chinese).
- [11] Regulations on Watch-keeping for Seafarers of People's Republic of China.
- [12] Pang Kaihua, analysis of 108 maritime investigation reports on ship collision accidents, shipping trade Bulletin No. 35.
- [13] Du Lei, Valdez Banda Osiris A., Goerlandt Floris, et al. A COLREG-compliant ship collision alert system for stand-on vessels. 2020, 218.
- [14] Yang Zuojia. Discussion on Compliance with STCW Rules and COLREG1972 [J]. China Maritime Safety. 08 (2017): 41-43. doi: 10.16831/j.cnki.issn1673-2278.2017.08.017 (In Chinese).
- [15] Kang II Kwon, Kim Hyung Seok, Kim Min Seok, Kim Jeong Chang, Lee A Reum. Collision risk considering the international regulations for preventing collisions at sea, 1972 [J]. Journal of the Korean Society of Fisheries and Ocean Technology, 2009, 45 (2).